Product Differentiation and Market Segmentation in Grains and Oilseeds: Implications for an Industry in Transition

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CONFERENCE SYNTHESIS[1]

This conference examined the implications for the U.S. grain system of significant shifts away from the production and marketing of generic commodities toward increased product differentiation and market segmentation. Several forces are at play, including biotechnological and industrial innovations, more differentiated demand and changing consumer preferences. Consequently, the grain industry is facing new demands for identity preservation, segregation and product tracing. These trends have implications for the organizational structure of production, processing and marketing, including contract production, and other market coordination mechanisms.

Participants explored new research results, industry responses and government initiatives related to product differentiation and market segmentation in the grains and oilseeds sectors. Topics included: drivers of differentiation in grains and oilseeds; contracting production for identity preserved (IP) grains; IP segregation costs and efficiency; distribution of identity preservation costs along the supply chain; incentives and risk management under identity preservation; price behavior under market segmentation; structural change and market coordination mechanisms in an IP grain system; and private and public roles in the IP market.

This report synthesizes the various topics and issues covered. Section I provides an overview of the main drivers underlying the process of differentiation in the grain system. A common set of issues was emphasized, such as the increasing role of information in the process of differentiation, but there were also qualitative differences in perspectives. Section II describes the recent trends in marketing differentiated and IP crops, with an emphasis on corn, soybeans, wheat and canola. It also contrasts developments in the U.S. and in Canada, and the impact of different regulatory regimes and international influences on IP trends in domestic markets. Section III delves into the economics of producing IP crops based on farm level surveys from the U.S. Midwest, including the economic incentives for risk and risk management strategies versus traditional commodity crops. Section IV reviews recent analytical work on price and market implications in increasingly differentiated grains and oilseeds markets, as well as quantitative analyses of the costs of segregation and identity preservation. Section V summarizes practical applications issues from the perspective of government, farming and grain marketing, IP service providers and the food industry. Section VI highlights implications for research and policy.

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[1] Prepared by Aziz Elbehri, Economic Research Service, USDA.

Section 1. Drivers of product differentiation

Steven Sonka of the University of Illinois at Urbana-Champaign, cites five primary forces driving differentiation in the agri-food industry. Biosecurity and traceability to the farm level may be desired by consumers if food safety is at stake or under a threat of bioterrorism. Environmental regulations could be imposed on agricultural commodities, with requirements for extensive and verifiable information based on the capture of data as operations occur. Biotechnology is also forcing differentiation. Social and political resistance to biotechnology in some parts of the world is an impetus for development of IP systems to segregate agricultural output. A fourth driver is precision agriculture, which employs advanced information and measurement technologies to monitor agricultural output levels, captures detailed information on crop growth, and allows for more accurate application of agricultural inputs. These technologies have the potential to reduce the cost of traceability, regulation compliance and crop segregation. The fifth driver is the Internet, e-commerce and wireless communications, which affect the costs of communicating information across geographically dispersed farming and marketing areas.

Sonka argues that product differentiation is a result of an economic gap between the traditional commodity supply chain and the IP system. The traditional commodity supply chain is based on anonymity and lack of coordination between the various points of supply. This system is characterized by large volumes, low costs, minimal quality standards and high purchaser flexibility. The IP system is characterized by two-way information coordination between input (e.g. seed) suppliers and end-users. The IP system operates under small volumes, higher costs and specific quality standards, but with less flexibility. An economic gap has developed between the two systems. The market wants specific quality specifications, considerable flexibility, large volumes, low costs and attractive margins (Box 1), demands that can be met by a differentiated market. Differentiation tactics involving farm level products are inconsistent with the current capabilities of the commodity system. The current IP market system appears to be too costly to allow for development of large-scale differentiation efforts.

Box 1

Today's alternatives

Commodity:
- **Large volumes/low benefit**
- **Low cost**
- **Minimal quality standards**
- **Maximum flexibility**

Identity Preserved:
Small volumes/high benefit
High cost
Specific quality standards
Minimal flexibility

Market wants

Specific quality standards
Considerable flexibility
Large volumes
Low cost
Attractive margins

Sonka emphasized the increasingly critical role of information under an IP system. In the commodity-based world, price information traditionally determines the amount to produce; an economy based on differentiation relies increasingly on information as an added dimension to the price determining mechanism. Economic institutions are mechanisms for structuring information flow to aid decision making. Information also affects the coordination and quality of decision making. With a greater role for information technology in differentiated markets, the rules of competition are redefined between suppliers and customers, as well as between customers and among competitors.

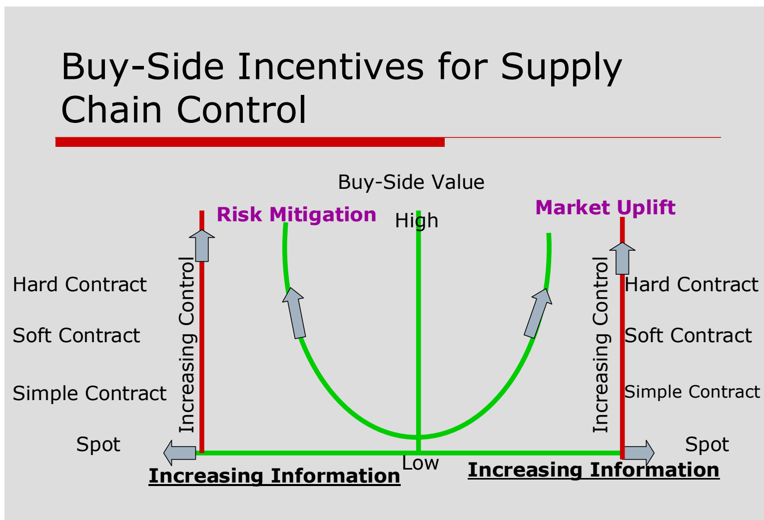
To anticipate the likely evolution of differentiation and market segmentation in the grains and oilseed sectors, an understanding is needed of potential linkages between market needs and information system capabilities. Greater attention must be paid to innovations that reduce transaction costs between producers and their customers. This points to greater emphasis on the information infrastructure to provide better information to customers on tangible and intangible attributes of the grain and oilseeds provided by farmer suppliers. The initial fixed cost is high but variable costs are low. Such a cost structure may be difficult for individual firms to justify but if provided as a public good, it could result in a substantial competitive advantage for the grain and oilseed sectors in the U.S.

Tom Sporleder of The Ohio State University, in a paper co-authored with Peter Goldsmith of the University of Illinois at Champaign-Urbana, places IP systems on a continuum. At one end is the commingled commodity, and at the other end branded products with all the information components of an IP system. In between are differentiated but not branded commodities. Sporleder also emphasizes the importance of information in a differentiated system. With increased differentiation, information flows become critical to mitigate risk and capture value-added. It becomes critical for farmer-suppliers to provide information to downstream customers. The greater the information flow along the supply chain, the more we move away from the spot market towards production contracts.

Sporleder defines five components of an IP system: segregation, metrics for quality, identity of the economic agent, geographic origin identity and production protocols. Segregation allows efficient channeling, but sellers may not receive sufficient premiums to cover the added costs. For buyers, segregation may also limit efficiencies from scale economies. Information specifying supplier identity may allow the seller to capture value, but may also focus product liability. On the buyer side, supplier identity provides added value if consumers value the source, but may add costs through reduced substitutability, flexibility and increased procurement complexity. Geographic origin may help the seller if there is value to be capture from geographic specificity. For buyers, geographic origin could provide added value to some customers but competition may be reduced. Knowledge of metrics for quality helps the seller know what they are offering and may inhibit free riding. Production protocols help the seller capture value or demonstrate due diligence, but could also be costly. For buyers, production protocol information reduces risk by attending to critical control points and demonstrates due diligence. On the other hand, information on production protocols may not bring any added value to the buyer or the underlying stochastic risk properties may be unaffected.

Increased differentiation implies reciprocal dependencies among vertically allied firms in the supply chain. Contracting has become the most effective mechanism to facilitate market coordination and has replaced buffer stocks as a hedge against the uncertainty associated with spot market transactions. Sporleder and Goldsmith classify production contracts into three broad categories based on research at the University of Illinois: hard, soft and simple (Box 2). Hard contracts are tight specification (process or outcome) contracts with penalties for compliance failure or even indemnification of the buyer. Soft contracts involve process and quantity specifications, but compliance failure involves no legal liability. For example, organic contracts in Illinois are highly specific, third-party verified, but involve no legal liability for failure to deliver. The most common contracts—simple contracts—specify minimal management processes (specify variety/hybrid and quantity); third-party verification is not employed. The demand for vertical information is reflected in a continuum of transaction governance structures as reflected by these contract types.

Box 2



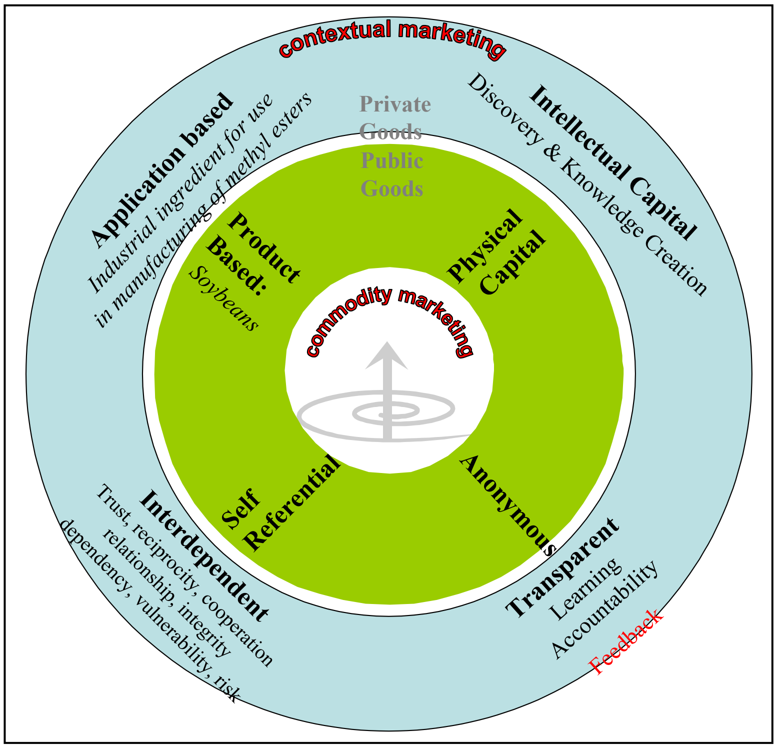
Source: Sporlder and Goldsmith (2003)

Frank Beurskens of AgriBiz, Co., described the transition of the grain and oilseed industry as a shift from a commodity-based system to one based on context. Commodity systems focus on the product; contextual systems focus on the use or application of a product or its components. Drivers of the commodity-to-context transition include biotechnology, which opens up endless possibilities for end-use applications; communication networks and the Internet; and globalization accompanied by open communication systems and trade liberalization. This can lead to over-capacity and product competition, resulting in downward price signals.

The relationship between commodity and context systems is illustrated in Box 3. Commodity marketing systems depend on physical capital to produce a product in an anonymous, self referential system. Standardization combined with anonymity assures efficient allocation between many anonymous sellers and buyers, with price being the primary coordination mechanism. The commodity marketing system is extremely efficient as long as the product is not burdened with communicating contextual information.

The contextual marketing system builds on the commodity marketing system, adding complexity to accommodate context-specific information necessary for knowledge creation and sustainability. Context specific applications require product differentiation and market segmentation to protect the integrity of information embedded in the product.
The contextual system is more transparent, but also brings new risks: liability, intellectual protection property, performance accountability and relationships. If the system is unable to deliver value, the default commodity system survives.

Box 3



Source: Beurskens (2003)

The advancement from product to context is driven by technology. Adapting new technologies introduces new relationships, according to Beurskens. "When corn was corn, a producer dealt with a local elevator to market production. When a high oil attribute was added, the producer still dealt with the local elevator but also entered into an additional contract specifying seed source, segregation and delivery requirements and other unique provisions," he explained. "The introduction of genetically modified corn introduced further complications, requiring improved record keeping, product segregation and in many cases DNA testing to further confirm purity. More recently, the experimental introduction of pharmaceutical corn introduced yet another responsibility and expanded liability." Each advance in technology brings with it additional complexity and dependencies.

Section II. Market segmentation trends in grains and oilseeds

Karen Bender of the University of Illinois at Champaign-Urbana, distinguished two primary distribution systems in grains and oilseeds in the United States—the traditional commodity distribution system, and a distribution system for very high-value traits, such as certified organic corn or soybeans. Neither of these two primary distribution systems can effectively supply differentiated value-enhanced crops, many of which are produced at higher volume levels than traditional, small volume high-value crops. These are the differentiated commodities referred to by Sporlder and Goldsmith.

In addition to the two primary distribution channels, new market channels are needed to service the new generation of differentiated products. Closest to the commodity marketing channel are value-added crops with easily measurable traits (high oil, high protein, and high starch corn). Low cost measurement technology, such as near-infrared, is available to determine these attributes at first point of delivery. Segregation on the basis of attributes follows. The next marketing channel uses variety-specific contracts. Farmers may be compensated for "yield drag" but low cost tests to check for varietal purity are not yet available. Next is the marketing channel ensuring absence of an attribute, such as non-transgenic corn or soybeans. Further along the continuum of supply chains are certified organic or high value-added IP market channels, such as pharmaceutical crops.

Bender reported survey data from Illinois which addresses how various value-added crops and their associated marketing channels differ in contract requirements and additional costs incurred by producers and elevators. The frequency of contracting varies substantially, from 38% for yellow food-grade corn to 85% for non-genetically modified (GM) soybeans. Depending on the specialty crop, contracts may specify variety, production management, quality tests, delivery, location and on-farm storage. While most contracts specify delivery location (100% of non-GM soybeans), few specify production management (as low as 13% for yellow food-grade corn). The differences imply different levels of additional production, handling and marketing costs.

Peter Phillips of the University of Saskatchewan**,** described drivers of product differentiation in the Canadian grain system—concerns about food safety, increasingly variable consumer preferences, diverging regulatory systems, and narrow operating margins. Many of these forces are global, reflecting Canada's sensitivity to international developments for its canola and wheat, which are largely exported. Canadian producers and processors are being pressed to find ways to satisfy the demands of consumers, regulators and commercial supply chains around the world.

Phillips cited three types of product differentiation trends in Canada's canola and wheat sectors: IP production and marketing (IPPM), segregation and traceability. IPPM is voluntary and privately initiated to extract premiums and markets within a closed loop system of second-party testing and auditing. Segregation is limited to those products under strict regulation to avoid commingling. It is mandatory and involves first-party tests and audits. Information flows only toward regulators, who are the final arbiters of the system. Traceability is initiated by a standards group to manage liability. Traceability can be voluntary or mandatory, involving a two-way information flow and third-party audits.

In the Canadian canola industry, several examples fall under the IPPM system, including organics, genetically modified organisms (GMO) input traits (herbicide tolerant) or output traits (high-oleic or low-linoleic oil). Several different IPPM systems operate within the canola system (Box 4). A number of companies extract a small premium from crushers by more closely managing varietal purity. IPPM is also adopted to facilitate the introduction of herbicide-tolerant transgenic varieties of canola, ensuring an IP system for the crop's delivery to crushers that produce for Canadian or U.S. market where approval is granted. The goal of IPPM is to avoid commingling within the traditional canola export marketing channels, including the handling system, elevators, rail cars and port terminals. Although there have been attempts to develop IPPM systems for organic canola, there is no reliable evidence on how these systems operate or their cost structures. There are also IPPM systems for proprietary non-novel trait varieties, such as improved oil content or varied oil profiles. These systems operate with significant premiums to enforce compliance; with no health issues involved, there is no liability in case of commingling.

Box 4

Canadian canola and product differentiation

Category	No.	Key traits
Spot market traded varieties	+165	None
IPPM - input/agronomic traits - GM input traits (not CR) - Output trait (not CR) - Organics	 Na 10 22 any	 Any spot traded varieties HT Specialty oils/content All except GM eligible
Segregated output trait varieties (requiring contract registration)	13	High EA; low lin/high oleic; high laurate
Traceability systems	0	Under development; CGC, 2003

Canadian wheat and product differentiation

Category	No.	Key traits
IPPM - input traits - organic market - output traits (not CR)	 0 Na 11	 - none - All varieties eligible - 11 selected varieties
Traceability	0	Under development CGC, 2003

Source: Phillips and Smyth (2003)

Unlike canola, the Canadian wheat industry remains a publicly managed industry. Most new varieties come from public breeding programs. The Canadian Wheat Board (CWB) manages purchase and sale of all Western Canada exports of wheat and barley. Several IPPM systems have evolved over the years, including direct sales of specific varieties or qualities between domestic millers and specific farmers. However, sales need to be booked through the CWB.

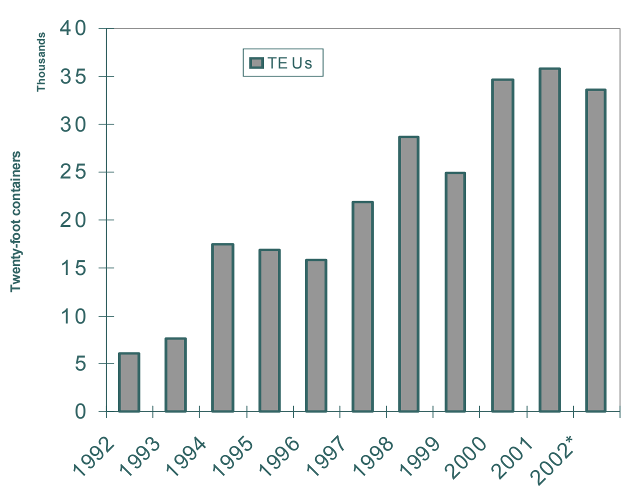
Direct sales through these contracts have remained small except for organic wheat. A number of IPPM systems have also been introduced to exploit differentiable output traits that would otherwise be blended into the various grades and classes of wheat and durum marketed by the Board. These systems are totally voluntary and are driven simply by unexploited market opportunities. Examples include a contractual arrangement between Warburtons, one of the United Kingdom's leading bakeries, and Manitoba Pool Elevators, which in turn contract with growers.

Other than IPPM systems, there are very few segregated systems in Canada. The best-known is high erucic acid rapeseed, which has high industrial value but is not suited for food. There are no examples of canola or wheat under a strict traceability system yet, but several prototypes are being considered.

Phillips concludes that while IPPM appears to be technically feasible for smaller units of production, it is unclear if they are economically viable long-term or for large scale operations. There is real concern in parts of Western Canada that vertically managed production systems will create winners and losers within the farm community. Better capitalized, more educated managers are more likely to be winners. Product differentiation fundamentally challenges the CWB structure of pooling to mitigate individual risk. Private, vertically-managed production systems for market or safety reasons have the potential to conflict with CWB policy.

Heidi Reichert of USDA's Agricultural Marketing Service, in a paper co-authored with Kimberly Vachal of North Dakota State University, described how developments in the shipping industry and the increased significance of containerized shipping can promote transportation for IP grains and oilseeds. Since the1960s, container shipping has become a common way to move all types of products, especially high-value cargo. Its use increased more than 5-fold from 1992 to 2002, on a weight basis as costs declined (Box 5).

Box 5



Source: Reichert and Vachal (2003)

Containerized shipments offer several advantages for IP products. Grain handling during transportation is minimized, containers serve as storage anywhere along the way, and just-in-time requests by customers are better met.

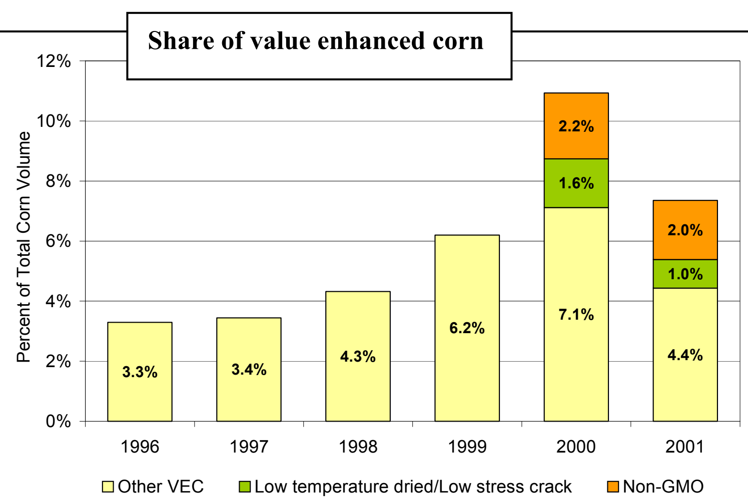
Reichert and Vachal described an economic decision model that illustrates the potential cost differences between marketing IP or generic grain. The model simulates alternative transportation and marketing costs by incorporating such factors as storage, handling, transportation, marketing and special charges. Several alternative transportation schemes are considered. Customers may also request specific product or delivery characteristics such as IP, organic, scheduled delivery over time, bagged product or just-in-time delivery. Cost comparisons take into account these alternative marketing arrangements. Model cost components include inland drayage, inland truck freight, inland rail, ocean freight and inland/ocean freight.

Section III. Economics of IP crop production.

Robert Stewart of Ag & Education Consulting, reported findings of a seven-year producer survey on value-enhanced grains conducted for the U.S. Grains Council. The survey focused on Midwest corn production. Respondents raising value-enhanced corn peaked at 15% in 1999 and declined to 11% in 2001 (mostly due to reductions in high-oil corn acreage). Growers of value-enhanced crops tend to produce slightly higher yields, have larger farms and have slightly more on-farm storage. Volume share of value-enhanced crops increased to 10.9% in 2000 from 3.3% in 1996, but fell to 7.4% in 2001 (Box 6).

The top reasons for growing VEC are premiums, satisfaction with previous results and the desire to be part of an emerging market. Buyer/elevator or seed sales encouragement had lower impact. Producer premiums for specialty corn showed a downward trend since 1999. Premiums were highest for white corn, ranging from 43¢/bu in 1996, to 29¢/bu in 2001. The high oil price premium was steady from 1996 to 1999 at 3¢/bu; it has dropped to 2¢ since 2000. Waxy premiums also trended downward to 20¢ in 2001 from 30¢ in 1997. Reasons growers cited for not growing value-enhanced crops included lack of sufficient incentives, limited market access or dissatisfaction with current practices. Also cited were reports of poor experience from others, storage handling constraints and perceived risks with value-enhanced crops.

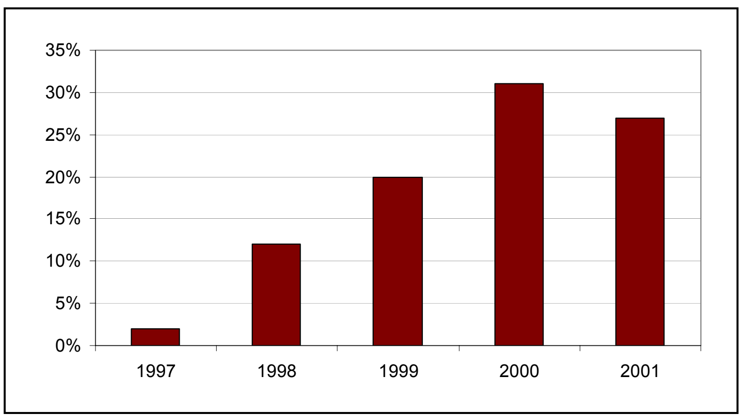
Box 6



Source: Stewart; 2001-2002 VEG Quality

A major survey finding was a high degree of turnover among producers growing value-enhanced crops—27% of growers did not plan to grow value-enhanced crops again the following year while 29% planned to enter the value-enhanced crop market in 2002. Producer turnover increased from 2% in 1997 to 32% in 2000, but declined to 27% in 2001 (Box 7). Yield performance was strongly associated with the decision to stay with value-enhanced crops. Among producers who planned to grow value-enhanced crops in 2002, yield drag was minimal or positive (higher yield than commodity); growers planning to quit value-enhanced crop production reported much larger yield drags. Typical yields by corn type were 92% to 98% for white; 91% to 97% for waxy; 97% to 100% for high-oil; and 89% to92% for nutritionally-dense. Stewart hypothesizes that the high turnover of value-enhanced crop producers may have a negative impact on the industry, creating inefficiencies in recruiting and training new growers. The high turnover may also reflect a market failure on the part of buyers (processors; food manufacturers) who may need to adjust price premiums or improve market coordination schemes with growers.

Producer turnover over time



Source: Stewart; 2001-2002 VEG Quality Report

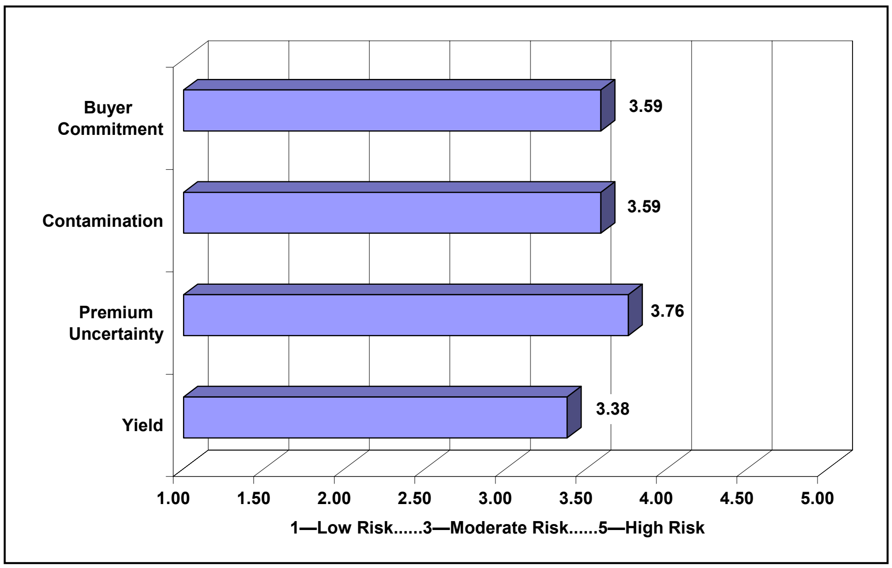
Growers indicated that producing value-enhanced crops required on-farm investments and equipment changes, including building new storage bins (8.4%); replacing/modifying drying equipment (5.7%); replacing or modifying harvesting equipment (2%); installing grain storage monitoring equipment (1.8%); and installing a grain cleaner (1.6%).

About half of all survey respondents believe the market for value-enhanced crops will continue to grow. There is also recognition of the need for better risk management tools—different from generic crops—due to the yield variability, yield drag and uncertainty about premiums.

Sharon Bard, Robert Steward and Lowell Hill, all of Ag & Education Consulting, co-authored a paper with Linwood Hoffman, Robert Dismukes and William Chambers of USDA's Economic Research Service, examining the risk implications of growing value-enhanced rather than commodity crops. A survey of Illinois growers addressed tools used to reduce the risks of value-enhanced crop production. Risks associated with growing value-enhanced crops included base price, price premium, quality, yield, market access, contract, relationship, product liability and investment. Price premium risk arises outside any changes in quality within the crop year, and is often linked to lack of a contract. Quality risk arises from an unexpected quality level in the grain that affects the value through discounts or reduced premiums. Contributing factors include variety, growing conditions, contamination and measurement (Box 8). Value-enhance crops may yield higher premiums for superior quality; generic commodities can only be negatively affected on grading. Value-enhanced crop production can also bring yield risks different from expected yield drag, as some varieties are more sensitive to weather conditions or yield variability.

Based on producers' actual experiences, lower than expected premiums is the most frequently stated problem for value-enhanced crops. Half of the respondents said crops were rejected for not meeting quality standards. Producers without contracts (48%) more often experience reduced premiums than did producers with contracts (32%). Less than 10% of total value-enhanced crop acreage received reduced or no premiums. Most didn't experience any problems related to GMO contamination, harvesting or storage. About 25% of value-enhanced crop producers had yield problems.

Box 8 Sources of risk for all respondents

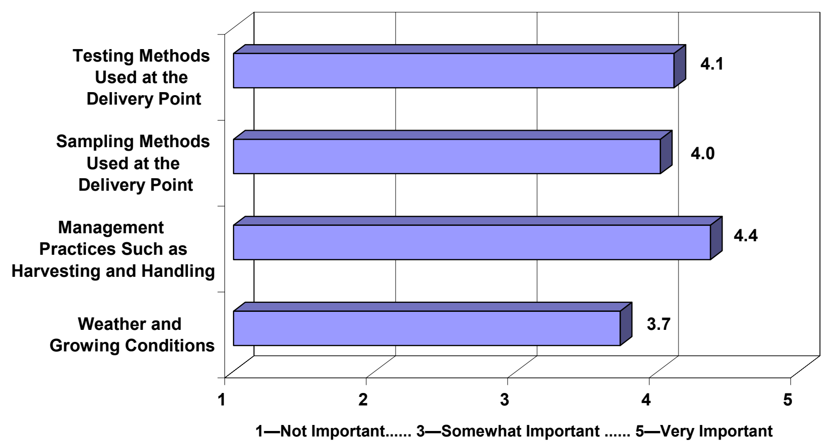


Source: Bard et al. (2003)

Producer perception of risk differed from actual experiences. Almost all producers surveyed felt there were higher risks with value-enhanced crops due to premium uncertainty, potential contamination and yield risk. Value-enhanced crops with compositional characteristics (white corn, tofu soybeans) were considered riskier than those with specialized handling traits. Non-GMO grains had lower perceived risks. Producers under contract perceived lower risk compared to those without contracts.

There are limited tools to help manage risks associated with value-enhanced crops (Box 9). One tool is a production contract, but not all production is under contract. Traditional crop insurance presents problems: value-enhance crops may have higher values than the commodity grain on which guaranteed levels are set; calculation of Actual Production History (APH) is based on commodity grain yields; and quality evaluation covers only severe problems related to generic corn production.

Box 9 Value-Enhanced Crop Risk Management Tools



Source: Bard et al. (2003)

Joan Fulton of Purdue University reported on a March 2000 survey of Indiana growers of value-enhanced corn and soybeans. About 15% of respondents produced a specialty grain, typically devoting about one-third of their farm to these crops; these farmers tended to have larger operations. Reasons for not producing value-enhanced crops included lack of market access (56%); additional investments required (40%); more management time required (36%); and high variable production costs (25%). Much of the added costs were transportation and handling.

Premiums varied among and within value-enhanced crop types. Premiums for corn waxy averaged 26¢ to 31¢, with lower premiums for white and food-grade corn. Tofu soybeans commanded the highest premiums, averaging 98¢; premiums for seed beans averaged 53¢ in 2000 and 34¢ in 1999. Additional net revenues for specialty corn are in most cases positive, but for soybeans, added value was as likely to be a negative as a positive.

Growers reported they entered into specialty grain contracts because of the additional revenue (92%); market access (37%); access to seed (28%); reduced price risk (21%); and access to technology (14%). Specialty contract provisions included delivery to specific location (89%); delivery on specific dates (74%); specified variety to plant (71%); and on-farm storage requirements (71%) (Box 10). Producers perceived production contract liabilities to be unknown delivery date, inconvenient delivery location, added costs, yield penalty, quality standards, identity preservation and loss of control.

Fulton examined correlations between factors associated with farmer decisions to grow value-enhanced crops, and factors associated with contract use. Explanatory variables were acres, type of operation (cash grain, grain and livestock, livestock or other), and GMO or non-GMO crop production. Growing specialty grain was positively correlated with farm size and with growing GMO crops. Farm type (grain, livestock, mixed) was not statistically significant in the logit analysis. Farm size was positively correlated to contracts, but growing crops for food or feed was negatively correlated. In other words, industrial-type crops tend to be more correlated with contracts.

Box 10

Activities Required by Contract	#	%
Deliver to Specific Location	152	89%
Deliver on Specific Dates	125	74%
Plan a Variety from a Designated List	121	71%
Store the Crop on Farm	121	71%
Provide Samples for Quality Testing	72	42%
Specific Pricing Method *(e.g. only fwd contracts)*	68	40%
Specific Pricing Window *(e.g. Sept.-Jan. only)*	63	37%
More Inten. Prodn. Mgt. (e.g.Pest./Herb. Programs)	52	31%
Specific Handling Equipment and Instructions	50	29%
Use Specific Harvesting Equip. or Specific Pract.	46	27%

Source: Fulton et al. (2003)

Fulton's analysis included a risk assessment component, comparing various value-enhanced crops based on differences in premiums received; additional net revenue earned; and premiums received with or without contract. Risk criteria used included expected value variance, first-degree stochastic dominance, second-degree stochastic dominance, and stochastic dominance with respect to a function.

Value-enhanced crops were categorized as efficient or inefficient based on associated risk. Soybean seed was more efficient than STS® (Sulfonylurea Tolerant Soybeans) soybeans relative to premiums received; the distribution of premiums for seed soybeans dominated the distribution of premiums received by STS® soybeans for both survey years. For specialty corn, white corn had the highest premium mean while food grade corn had the lowest. Waxy and high oil corns were efficient based on expected value variance, first-degree stochastic dominance and second-degree stochastic dominance. Under stochastic dominance with respect to function, only white corn remained efficient. That means more risk-averse producers would prefer the premiums associated with white corn than those of other specialty corn varieties. Similar results were seen with respect to additional net revenue criteria compared with the premiums.

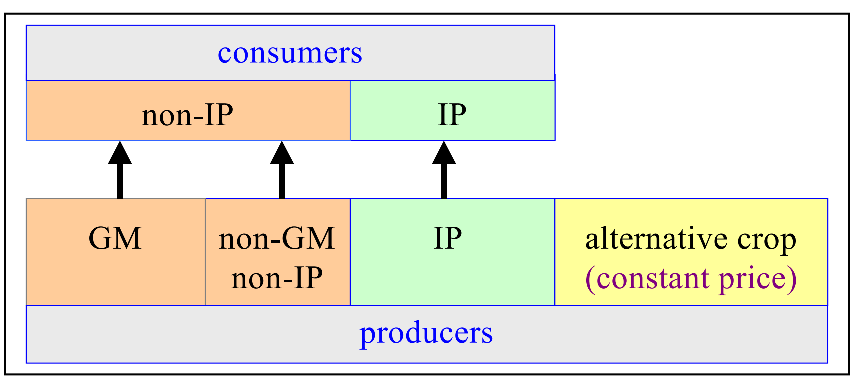
Under expected value variance criteria, growing seed soybeans under contract was efficient (least risky) while producing without contract was not. Under first- and second-degree stochastic dominance, both contract and no contract were efficient. Under stochastic dominance with respect to function, producing without contract again became inefficient. For STS® soybeans, both contract and no contract production was efficient for expected value variance; for first-degree and second degree stochastic dominance, as well as stochastic dominance with respect to function, only contract production remained efficient. For corn, the pattern is the same for food grade, waxy and white corn. Under expected value variance, contract and no-contract were the least risky. Under the other three criteria, producing under contract was efficient, while producing with no contract was in the inefficient set. For high oil corn, both contract and no contract are efficient for expected value variance and first-degree stochastic dominance, but production with no contract was in the efficient set for second-degree stochastic dominance and stochastic dominance with respect to function.

Section IV. IP Costs and Market Implications

Marion Desquilbet of INRA, France, and David Bullock of the University of Illinois-Champaign-Urbana, presented a conceptual model of price and welfare analysis of the rapeseed market in the European Union (EU) under alternative IP cost assumptions. New regulations on biotech labeling and traceability are moving through the EU legislative process. EU Agriculture Ministers reached agreement on a new GMO authorization and labeling protocol in November 2002, and Environment Ministers reached a compromise solution on traceability of GMOs in December 2002. Lifting the EU moratorium on biotech varieties approval is possible, but there is still strong consumer opposition in the EU. The result could be a dual market, with some EU farmers adopting GMOs and other farmers, grain handlers and food processors segregating GMOs from non-GMOs.

Desquilbet and Bullock developed a conceptual model for determining the costs and benefits for a dual-market system of GMO and non-GMO rapeseed (Box 11). Non-GMO segregation and IP generates two types of costs—costs to physically separate non-GM IP goods and regular goods for which no steps are taken to prevent GMO commingling in the supply chain; and costs to validate IP claims, such as testing, contracts and compliance. There also indirect costs imposed on the regular producers because segregating regular and IP goods in the supply chain results in a loss of the flexibility of grain movement. This indirect cost increases in proportion to the relative shares of GM and non-GM production.

Box 11 Model structure (Desquilbet and Bullock, 2003)



Model simulations showed how results are affected by the presence or absence of externality costs given two types of EU consumers—indifferent and opponents. Alternative assumptions were run under different degrees of opposition to GMOs. Simulation results showed that welfare was different when an IP externality is assumed. Indifferent consumers may be hurt when some consumers are opposed to GMO and are willing to pay any price for only non-GM products. In this scenario, IP producers are also hurt by the introduction of GMOs. The introduction of externality costs partially rebalances welfare effects between the two types of producers and between the two types of consumers.

Aziz Elbehri of USDA's Economic Research Service presented a paper co-authored with Philip Paarlberg of Purdue University, which examined the price and market implications of the corn sector under product differentiation. The study model separated the corn sector into several market segments, including several IP types and generic commodity corn.

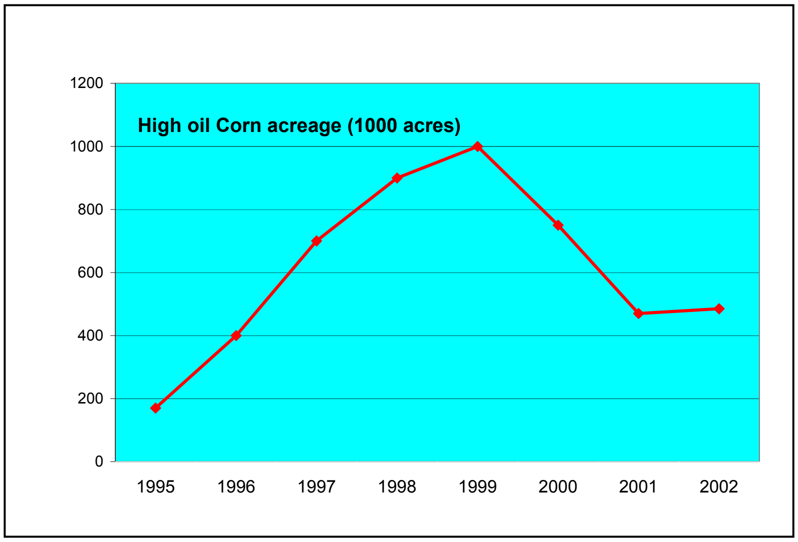
The coexistence of many specialty corn types and generic corn has important market implications. With variability in price premiums and higher risks, specialty corn production can be subject to a high degree of variability in supply and demand compared to generic corn. High oil corn is one of the fastest growing specialty corns (Box 12), Acreage peaked at 1 million acres in 1999 before sliding in subsequent years due to increased competition from such sources as lower feed fat prices and higher quality generic corn. Price premiums for high oil corn have declined since 2000, reducing farmers' incentives to grow it.

Specialty corn that involves direct contracts between growers and processors, as in the case of waxy and high amylose corn, also raises the question of how much value is shared between growers and processors given the market power of the latter and the potential for oligopolistic behavior. Prices and price premiums could diverge from the standard situation of open markets and perfect competition.

The paper by Elbehri and Paarlberg cites a corn market made up of generic commodity corn and five specialty corns—white, nutritionally dense, high oil, waxy and high amylose. The first three are treated as perfectly competitive sectors since there are many producers and users of these crops. The small number of firms processing waxy and high amylose corns into starch, introduces oligopolistic behavior and market power features. A markup-pricing rule is derived for price determination. Processors can influence the price paid for purchased corn input, or price received for supplied starch.

The model can run simulation scenarios affecting differentiated demand and supply conditions for specialty corn versus generic corn. It can also be used to look at scenarios that examine increased competition in the oligopolistic corn processor sector. The model solves for new quantities and prices by corn type, as well as changes in price premiums. Simulation indicated that price and market implications of growing specialty corn depend significantly on their interaction with the generic corn market. The results also suggest that given the large market share of commodity corn, the impact is greater on specialty corn than the reverse.

Box 12



Source: Elbehri and Paarlberg (2003)

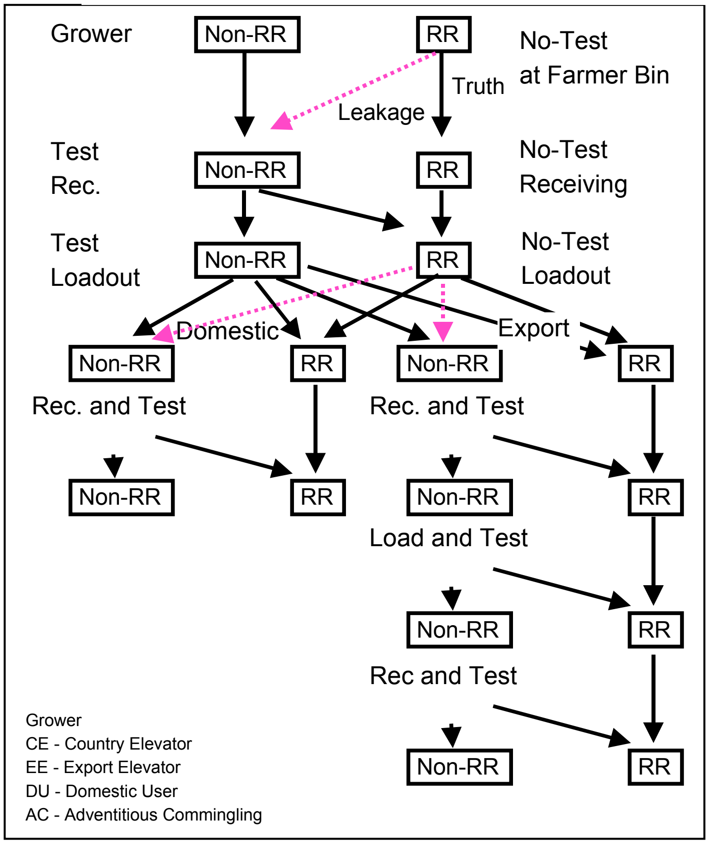
William Wilson and Bruce Dahl, both of North Dakota State University, examined the role of testing wheat for GM content. While wheat has had many traditional modes of differentiation—classes, grades, protein level and quality—the prospect of GM wheat release adds a new complexity to the wheat market, creating the potential for multiple markets segregated on the basis of GM presence. Testing is key to ensure segregation based on buyers' demands. Risks associated with testing vary by technology and tolerance levels. In the case of GM wheat, testing will only apply to non-GM shipments, with buyers including tolerance specifications in contracts for commercial or regulatory reasons. An acceptable test/sampling procedure would have to be determined. Growers also may declare varieties, which would provide information essential for segregation and testing strategies.

Wilson described a model of grain flows reflecting a dual system with testing and segregation of GM/non-GM flows from growers to importers (Box 13). The objective is to determine the optimal testing strategy (where to test and how often to test), costs and risks, and to minimize cost subject to a 1% tolerance level. The model operates as a stochastic optimization that incorporates risk and uses an objective function to quantify a risk premium.

Testing points along the marketing chain include farmers, elevators, export elevators and importers. Farmers declare GM/non-GM on delivery. Elevators choose if and how frequently to test; segregate based on the variety declaration and/or tests; and may test on loading out. Export elevators choose to test and segregate based on test and/or knowledge of GM content. Finally the importer tests before accepting or rejecting the load. Costs include testing, rejected shipments sold at alternative markets, and risk premium to handlers. The model derives additional system costs at each stage of the marketing chain, tracks the flow of segregation throughout the system, and derives statistical properties on the proportion of shipments with GM exceeding specifications in end-use flows.

The optimal testing and segregation strategy could vary depending on patterns of geographic adoption, penalties and tolerance levels. Buyers also influence impact testing/segregation through contract terms, test specification and penalties. Prescribed or routine testing practices will likely be sub-optimal and more costly. Simulation results for the base case indicated an optimal testing strategy is to test every fifth unit at the country elevator when loading, and every unit loading at the export elevator.

Box 13 Grain Handling Model (Wilson and Dahl, 2003)



Nicholas Kalaitzandonakes and Alexandre Mangier of the University of Missouri, examined the relationship between IP supply chains costs and purity standards. Purity standards are critical, particularly when set through regulatory decree rather than by market initiative. An example is the mandatory labeling regimes for GM foods under consideration in the EU, which require purity standards that separate GM and non-GM foods. More information is needed to determine the costs of these purity standards.

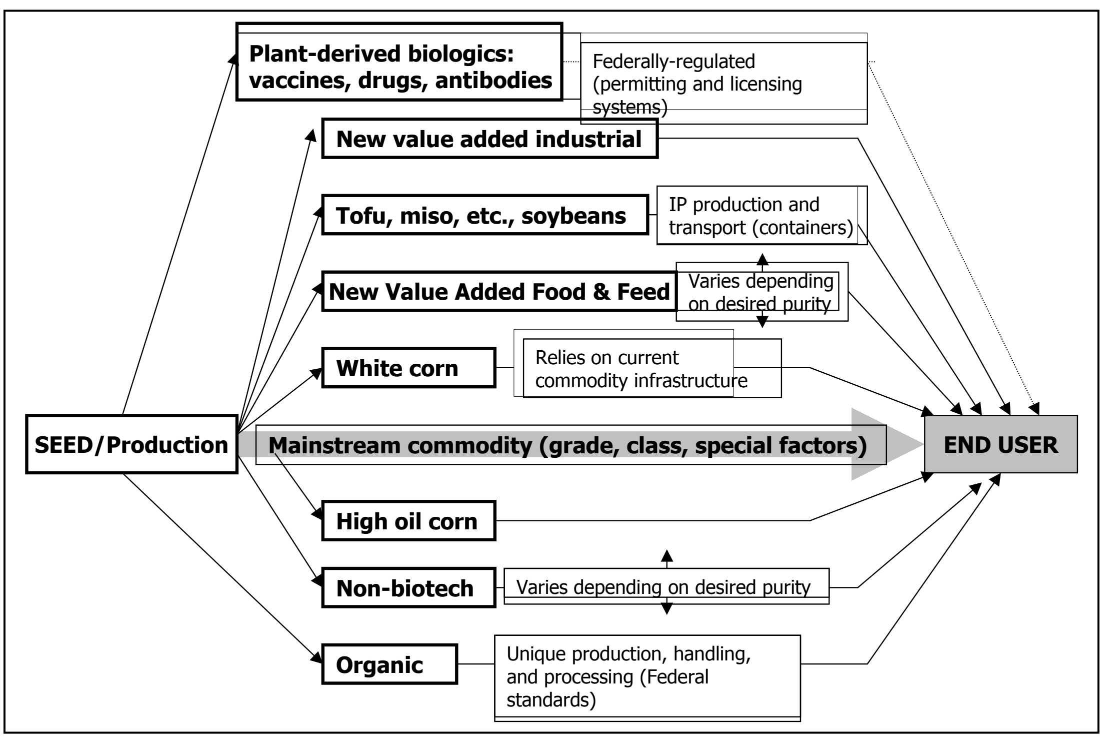
The authorsevaluated the impacts of purity standards on the production costs of seed corn in the U.S. The seed corn industry was used due to its adherence to strict IP protocols and purity standards in its standard production operations. The authors quantified how costs vary in such IP supply chains when purity standards are progressively increased. The analysis used process and economic engineering techniques (PRESIP) developed at the University of Missouri and actual data from representative seed corn production systems and processing facilities in the U.S. The results indicated IP costs increase non-linearly as purity standards become high. At extremely high levels (i.e. above 99.5%), IP costs increase abruptly, almost doubling.

Section V. Public and Private Initiatives

With the increased share of value-enhanced and differentiated crops, as well as the increased number of product channels (Box 14), the public role in differentiated agricultural product markets has increased. David Shipman, deputy administrator of USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA), reported survey findings that show 20% of grain industry leaders think identity preservation is important today, while 69% think it will be important five years from now. While 68% say U.S. grain standards are important, only 42% think they will be in five years. Regarding diagnostic systems for quality attributes, 31% think they are important today and 76% think they will be in five years.

According to Shipman, GIPSA's core business has expanded to include new public initiatives in differentiated product marketing. GIPSA establishes grades and standards; develops analytical methods; and provides an official inspection system. GIPSA's Process Verification Program is a response to public recommendations that USDA remain active in international discussions of standards, tolerances and labeling; continue to establish grades and testing standards; develop new testing and analytical methods for end-use quality attributes; and develop a verification program based on process, not just product content.

Box 14



Source: Shipman et al. (2003)

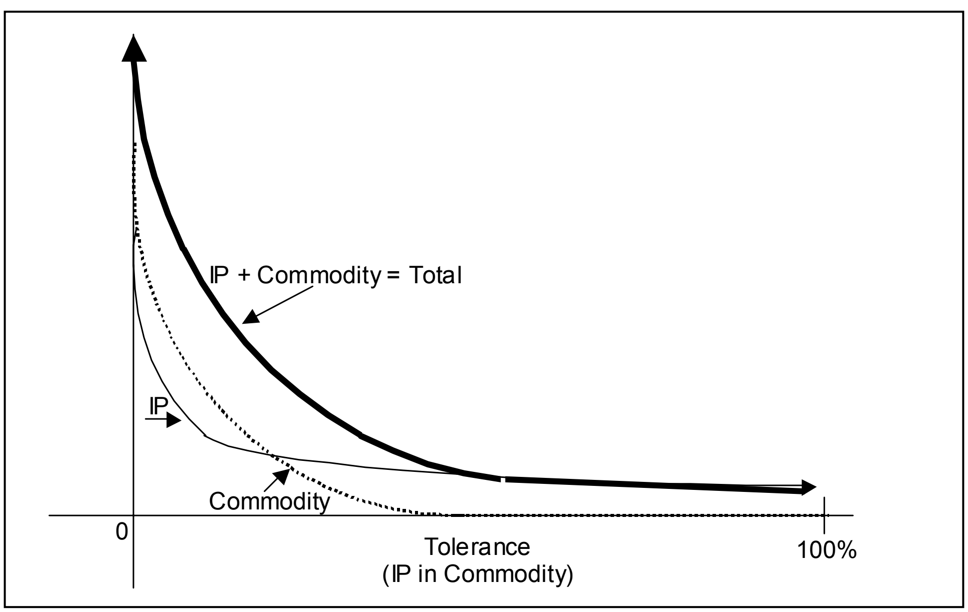
Through the voluntary program, GIPSA verifies quality policy, objectives and procedures developed by a company. If approved, the company can market its process or product as "USDA Process Verified". Based on ISO 9001-2000, which focuses on process not products, is user-fee funded and market driven.

Charles Hurburgh of Iowa State University, described a case study of an Iowa farmer-owned cooperative that uses process control and source verification. Process control is critical when traits valuable in the market are not discernable through testing, such as how a crop is produced. Source verification is the ability to trace products from their initial components through production and distribution to the end user.

Process control creates efficiencies and helps monitor the added costs of an IP system. If IP product is unapproved or unacceptable in the commodity market, costs are incurred in both the commodity and the IP system. One example is StarLink corn. Acceptable IP products create costs only to the IP program (Box 15). The key variable is the allowable limit or tolerance; at 100% tolerance (fully accepted), the only costs are for testing and handling to meet customer requirements. The smaller the tolerance, the greater the effort to maintain perfect isolation. Low-tolerance products are likely to be high value and more complex to test, so the basic cost of the IP program may well be higher.

Hurburgh described the steps the cooperative took to have a fully operational quality management and process control system. Initially the ISO 9000 system was selected as the quality system, but difficulties in implementing a system more geared to manufacturing than agricultural setting, led to a switch to the American Institute of Baking's Quality Systems Evaluation (QSE). The latter also has established credibility, third-party auditing and global recognition. The source verification process was divided into nine areas: raw materials, process control, process verification (statistics), finished product acceptability, storage in shipping, instrument accuracy and calibration, personnel training, plant programs (safety) and quality policies (management commitments).

Box 15 IP Share in Commodity System and Costs (Hurburgh, 2003)



The cooperative initially began the quality management system as a means to create more marketing opportunities in the emerging IP market. The cooperative soon realized added value from quality management systems even without developing new markets. Benefits included training, better documentation which improves routine but critical operations, statistical performance evaluation, programmed corrective action, improved precision of inventory management, and the establishment of a food-grade mindset among employees. Operating efficiency and cost savings were realized. Industrial firms have averaged $1.50 to $2 savings for every $1 invested. The chain-of-custody documentation required for a comprehensive quality management system can be a major benefit in marketing sensitive or narrowly focused products.

Iowa farmer Bill Horan described his experience growing and marketing IP corn and soybeans, including pharmaceutical corn. Horan operates a 4,000 acres farm and grows certified seed, tofu beans, waxy, nutritionally dense and pharmaceutical corns. The latter is grown under a contract with a French pharmaceutical company. Under terms of that contract, the Horan farm instituted a dedicated production system with dedicated planter, combine and storage, as well as temporal separation. Pharmaceutical corn must be planted at least 21 days after the last corn field sown within a one-mile radius. In addition to physical separation with uncultivated borders, all male tassels are manually removed; pollination comes solely from commodity corn—two rows grown next to each four rows of pharmaceutical corn.

Horan hopes to capitalize on the new industrial crop opportunities created by advances in genetic engineering. Such an operation is at the forefront of new farms with highly specialized identity preservation systems working in close coordination with industrial end-users. These types of farm operations are highly knowledge, skill and capital intensive. Horan benefits from his farm's geographical location, with easy access to an extensive knowledge infrastructure, including the Iowa State University Plant Science Institute, Center of Crop Utilization, University of Iowa School of Pharmacy and manufacturing clusters.

Lynn Clarkson's firm, Clarkson Grains Company of Illinois, procures and supplies IP soybeans to food processors for tofu, soy milk, tempeh, natto and miso. Demand for IP soybeans is strong in this segment of the food processing market, driven by competition, value, taste, consistency and avoidance of genetic engineering. Clarkson's customer base is global. He contracts with farmers in 15 states to raise selected soybean varieties according to client needs. In an IP system, the soybeans are conditioned and supplied based on such traits as variety, production method, physical characteristics, biochemical characteristics and seed development. The company's work is driven by customers' willingness to pay premium prices to acquire the desired products. Farmers growing beans under contracts under IP systems (segregated storage, third-party testing and process audits) are responding to premiums to deliver specified varieties.

Supplying organic or non-GM IP soybean varieties presents challenges to a grain handling company like Clarkson Grains. Organic grain marketing requires certification—the National Organic Program in the U.S.; IFOAM in the European Union; and JAS in Japan. Certification is required for farm, seed, transportation (dedicated means and specified transfer points) and both on-farm and commercial storage. In addition, there is no price indexing for U.S. organic grains.

Supplying non-GM IP grain also has its challenges, particularly if the tolerance required for GM presence is as low as 0.1%. Further contract production generally requires special attention to items such as farm certification, farm location and distribution, farm infrastructure, GMO barriers, and on-farm storage.

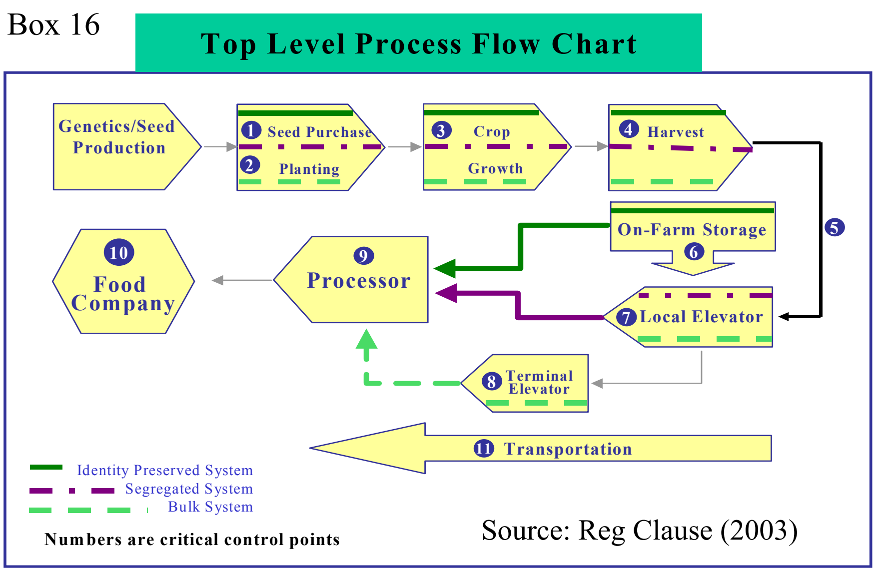
To maintain IP-specific varieties, on-farm storage is critical. Logistical challenges can result from scattered production, requirements for dedicated trucking, loading supervision, leased rail cars and clean box certificates and affidavits. Management strategies are required to meet security/traceability requirements, including sampling, testing and process audits.

Reg Clause of Iowa State University, described the role of the Center for Industrial Research and Service (CIRAS) in providing ISO 9000 certification to agricultural firms. Current trends to adopt process control and certification can be found among cooperative elevators, feed mills, farmers and pork production systems. The need for such certification and implementation of process control increases as demand grows for differentiated products. Global factors include foreign competition, requirements of foreign market consumers, and GMOs. In addition, consumer demands for food safety, quality and convenience, as well as retail and food service consolidation and political activism call for more certification and quality assurance.

Examples of certification and quantity assurance processes included proprietary systems such as InnovaSure, NOVECTA and Newell Cooperative; product-based systems, such as Certified Angus Beef, Genetic ID; or process-based systems (ISO 9001-2000, AIB-QSE, USDA Process Verified, and Certified Organic). The international process standard is ISO 9001-2000, a quality management system for establishing process control, maintaining a customer orientation and achieving continual improvement. The 2000 version of ISO addressed complaints that ISO 9000 was not user friendly in agriculture.

Clause used the illustration in Box 16 to show how a quality management system would operate throughout the supply chain. Ten control points are identified along a top flow chart: seed purchase, planting, crop growth, harvest, on-farm storage, local-elevator, terminal elevator, processor and food company. Several flow paths can be identified, based on the type of marketing system: bulk, segregated or IP. At each control point, activities, controls and records support the quality management system under ISO-9000.

Box 16



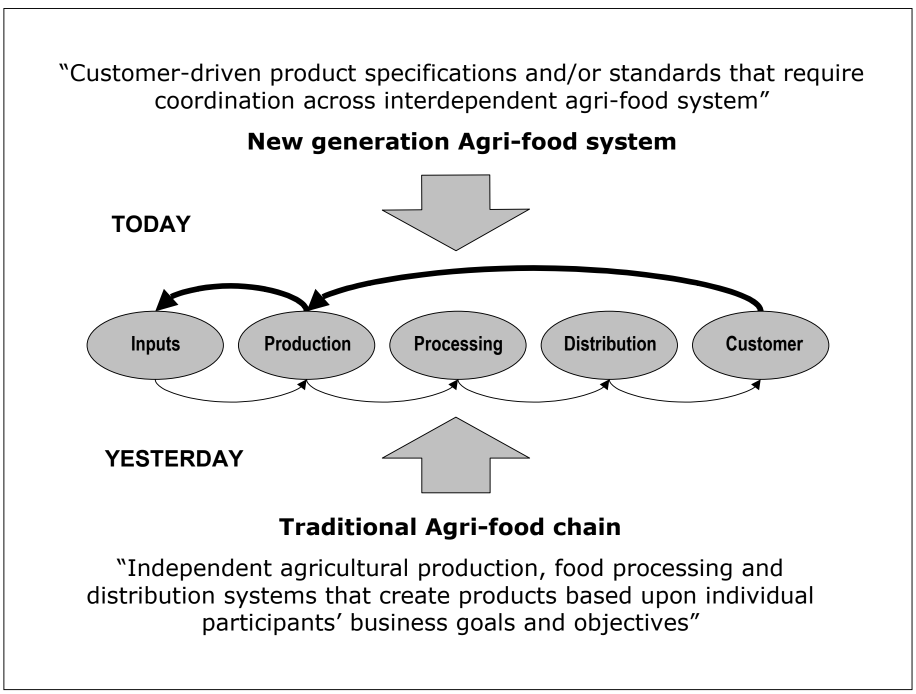
Source: Reg Clause (2003)

Genetic ID NA, Inc., provides certification for specific non-GM IP products. Genetic ID is a private third-party certification and process control provider, for clients certification with specific non-GM products, products under regulatory compliance, and organic crops.

Genetic ID offers its services under the Cert ID standard system, which verifies non-GM or other trait specifications within the supply chain, adding the Cert ID seal on products at the end-user level. Cert ID certifies process-based traits which cannot be ascertained by direct testing, such as meat product derived from animals fed non-GM feed. Cert ID offers traceability from the seed company, farmer/cooperative, elevator, processor, manufacturer and retailer. Certification, done by an independent third-party, includes standards, sampling, testing, inspections, documentation and seal. An electronic database stores all traceability documentation, testing results and administrative actions, allowing rapid access to full traceability from seed to retail shelf.

Bill Grande explained that his company, Identity Preserved.Com, uses an on-line certification and process control system. The need for process-based certification is driven by the recognition that decisions are made beyond price. This third-party service meets a critical need not directly met between production and procurement.

Box 17



Source: Bill Grande (2003)

IdentityPreserved.Com offers IP Track, an on-line based data management system that provides quality systems with protocol administration and compliance; permission access for data entry;

and remote auditing. Protocols can be viewed project-wide or within a particular lot. IP Track also offers traceability and lot historical data. IP Track provides the tools to gather and manage the hard data needed to meet IP certification and compliance requirements, and establish or confirm marketing claims. It offers a dynamic IP management system for a transparent, traceable and authenticated differentiated crop program. IP Track does this by combining process-oriented quality system components, with Web-enabled protocol posting and compliance software.

Trends toward identity-preservation and segregation of grain ingredients are affecting food manufacturers of branded products in many ways, reported Ron Olson of General Mills' Grain Division. He cited a greater need for direct interaction between food manufacturers and plant breeders. Traditional traits sought by producers (higher yields, insect resistance, protein content) are being supplanted by such output traits as texture, digestibility, nutrient content and processing ability. There is a shift from open access to proprietary ingredients, which affect competitiveness; this creates market opportunities and risks. Another impact is a shift toward more interdependence, implying a shift in market power and rules of engagement. This may not require vertical integration, but more "virtual" coordination through a higher level of cooperation. A higher level of trust is needed, at the price of some loss of control. A clearer definition of private and public regulatory structures needs to evolve.

General Mills uses primarily wheat and oats. Several years ago the firm began to segregate by varieties for quality assurance. The segregation system includes testing, variety separation and estimating correlations between grain traits, product quality and manufacturing flows. General Mills contracts with farmers to produce specific grain varieties on more than 250,000 acres. It requires certified seeds, relies on geographic diversity, and maintains close interactions with growers via farmer councils and chat rooms.

General Mills can trace product from the retail shelf to the time and place of manufacture, ingredients used and who supplied those ingredients. Complexity rises exponentially as many ingredients, such as grain, milk and sugar, are blended together. Most grain is assigned an identifying lot number at point of first unload into the grain handling system. All food products use UPC codes to allow trace back; these codes could be extended further down in the chain to each individual grower.

Economics will also drive traceability and testing at different points in the supply chain. The economics of the market will determine the degree to which traceability happens. The difference between certifying product or process must be understood. Depending on tolerances, if they are established, does testing create a clean handoff from a liability standpoint? The process could work to a high degree of integrity, and yet the product fail due to something created only by a specific raw material. Among the issues to resolve is the balance between risk and revenue. With an imbalance in market power, liability when it occurs may be difficult to share. Balancing economics and risk becomes more onerous as tolerances shrink, and marketing companies factor in consumer needs/perceptions. Traceability or source verification should be for appropriate testing at critical points in the chain provides the primary check.

Section VI. Research and policy implications

A number of research and policy implications were identified by conference participants:

- Discussion on this topic has evolved from whether the U.S. would/could differentiate products, to the appropriate private vs. public roles in the process.
- USDA sees government roles as including regulatory enforcement of segregation; market facilitation via process verification; setting standards, as in organic foods and testing; dissemination of information; and being involved in setting international standards. Maintaining international markets may require supplying more sophisticated products. There are policy implications for taxes and research.
- Expectations for IP in commodity grains are largely driven by biotechnology. There is new knowledge to be gained, and the need for better operations links, i.e. projecting future customer demand.
- How do farm programs affect the forces underlying differentiation and identity preservation?
- Private-government partnerships are important, and there is a need for domestic and international standardization. Ultimately the government's primary responsibility is to protect public health.
- While identity preservation is becoming increasingly important, its underlying forces encompass many issues, such as health, safety, security, trade. From a research perspective, there is a need for uniformity of technology, especially, the information component of identity preservation; clarification of terminology; and better understanding of economic drivers for vertical coordination in the supply chain. Research approaches may include transaction costs economics; traditional microeconomics; principal-agent approach in cases where market power is an issue; or resource-based theory.
- There is research needed into a classification system for contracting. The complexity of supply requires new concepts for contracts. Strategic alliances are increasing in the supply chain not only through contracting, but also through extensive discussions/informal contacts.
- The concept of causality, which is linear in the commodity world, is less straightforward under identity preservation. In the last five years, there was a lot of emphasis on analyzing the cost of IP systems. What is needed is a systems approach of which cost is only one component. Cost needs to be viewed in a portfolio context. Price premium is a dynamic concept.
- There is a need to understand the value of what we can measure, since what is measured gets rewarded.
- There is a need to better understand the genetic composition of food products. This could be disruptive, because in the seed industry, perceived values may not correspond to actual genetic information.
- Entrepreneurship is key to the move toward an information/technology intensive commodity system.

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